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Boundary crossing – A theoretical framework to understand the operational dynamics of industry-school partnerships

Abstract

Industry-school partnerships (ISPs) are increasingly being recognised as a new way of providing vocational education opportunities. However, there is limited research investigating their impact on systemic (organisational and structural) and human resource (teachers and education managers) capacity to support school to work transitions. This paper reports on a government led ISP, established by the Queensland state government. ISPs across three industry sectors: minerals and energy; building and construction; and aviation are included in this study. This research adopted a qualitative case study methodology and draws upon boundary crossing theory to understand the dynamics of how each industry sector responded to systemic and human resource issues that emerged in each ISP. The main finding being that the systematic application of boundary crossing mechanisms by all partners produced mutually beneficial outcomes. ISPs from the three sectors adopted different models, leveraged different boundary crossing objects but all maintained the joint vision and mutually agreed outcomes. All three ISPs genuinely crossed boundaries, albeit in different ways, and assisted teachers to co-produce industry-based curriculums, share sector specific knowledge and skills that help enhance the school to work transition for school graduates.

1 Introduction

Internationally, employers and educational institutions are actively pursuing partnerships with schools. These arrangements operate through policy and funding mechanisms (Cardini 2006; Davies & Hentschke 2005) to address the needs of a post industrial age knowledge economy. A variety of terms are used to describe such partnerships, including the following: education business partnerships; public private partnerships; school enterprise cooperation; business school relationships; school business partnerships; community school partnerships; and industry school partnerships (Gajda 2004; Pillay, Watters & Hoff 2013; Stanely & Mann, 2014). Robertson, Mundy, Verger and Menashy (2012, 1) at the broadest level have described these partnerships as "cooperative institutional arrangements between public and private sector actors". Regardless, the various terms employed represent the variation between approaches and aim to encapsulate the mutual benefits for each partner.

The aim of this paper is to report on how partnerships have been developed between three major industry sectors and schools at a systemic level. This paper extends on an earlier exploratory paper that reviewed only a single industry (Flynn, Pillay & Watters 2014). Additionally, the paper describes how knowledge of such partnerships enables teachers and school managers to build confidence and competency for working effectively with industry. The

study reported here involved the Queensland State government, Gateway to Industry Schools Program as an industry school partnership (ISP) to address perceived skill shortages and to promote economic development in key industries (Watters, Hay, Pillay & Dempster 2013). The industries involved were centred on minerals and energy in the resource sector, and building and construction and aerospace industries. For clarity, this paper will use MBA ISP when referring collectively to the three industry sectors involved in the ISP.

1.1 Benefits of industry school partnerships

The benefits, that ISPs offer employers, teachers and education managers, and students, are well documented (Pillay, Watters, & Hoff 2013; Stanley & Mann 2014). For example, a recent report disaggregated the highly regarded German school to work transition process and found "rich and mature links between education and business with work-related and work-based learning valued and ingrained throughout" (Partnership for Young London 2015, 18). Such robust arrangements in Germany should not be invalidated by other countries as unreplicable despite the obvious cultural differences. Or, least of all, because of the consistently low rate of German youth unemployment (7.5%), when compared with other countries (OECD 2014). Regional programs are observable in other countries, such as the Education and Employers Taskforce in the UK, and the ISP in Queensland, Australia reported on in this present paper (Stanley & Mann, 2014). In New York, the P-TECH School Model is attracting global attention with its partnership between IBM Corporation, NYC Department of Education and NYC College of Technology (see http://www.ptechnyc.org/domain/43). This innovative concept spans grades 9-14 and targets specific degrees in applied sciences that have direct connections to entry-level jobs that connect to a career ladder.

2 A boundary crossing framework for industry school partnerships

Establishing an effective ISP is challenging because each partner has different objectives and their own frame of reference (educational versus business frames of reference), which makes the assimilation of new knowledge difficult (Mezirow 2003). Nevertheless, despite the diverse perspectives of each partner, there are mutual benefits in resolving the differences. A concept described in the literature as boundary crossing yields a potentially constructive way to address the significant systemic and human resource capacity differences between schools and industries. Engestrom, Ritva, and Merja (1995, 333) succinctly explains boundary crossing as the ability to "step into unfamiliar domains". Given the career pathway, training and experiences of most teachers, this provides a challenge for teachers engaging with industry. For this reason, it is hoped that this paper contributes to teacher confidence and competence to operationalise ISPs.

In ISPs the boundary crossing process occurs at two levels. Firstly, boundary crossing is a way of identifying and negotiating obstacles to the formation of the ISP and improving compatibility for functioning in the new setting (Akkerman & Bakker 2011a; Star & Griesemer 1989). Engestrom et al. (1995) identifies various obstacles to boundary crossing such as consensus in sub groups, which may prevent objectivity in determining purpose for ISPs.

These obstacles can be resolved as a shared vision for the partnership if established and shared problems are addressed (Billet, Ovens, Clemans & Seddon, 2007; Pillay et al. 2013).

Secondly, as a primary purpose of ISPs is to facilitate school-to-work transitions, as well as transitioning to further vocational and university education, there are outputs (such as industry based education programs) for school students that enable boundary crossing and development of a student's compatibility and readiness for work. The implication is that students must be afforded opportunities to participate in legitimate boundary crossing and authentic vocational education experiences, and thereby increase their personal employability (Billet 2002; Wenger-Trayner & Wenger-Trayner 2015). Engestom et al. (1995) asserts that this can occur as two communities of practice (school and industry) are connected. This implies that respective experts (teachers and industry employees) engage in boundary crossing to enact a hybrid learning space for students where formal, school-based learning and workplace experiences can be closely connected (Zitter & Hoeve 2012). To facilitate the above, the industry partner often provides resources, such as access to contemporary tools and knowledge products that teachers may use to enhance the school to work transition experience of the students.

In ISPs, schools also need to facilitate boundary crossing with industry. Central to this is the enabling role of the school teacher. Schools have organisational and structural boundaries (fences) to keep students in and others out; there are many legislative boundaries that exist to protect children; and there are government boundaries that gate keep (approval processes), for instance, which curriculum is taught in schools. Industry is also defined by boundaries. They set entry standards for employment; they are bound by legislation such as workplace health and safety; they have certain cultural and behavioural boundaries expressed in codes of conduct; and they standardise operations in policies and procedures.

Akkerman and Bakker (2011) identified through an extensive literature review four boundary crossing mechanisms, which are presented in Figure 1. These researchers suggest further research to investigate, "whether and how these four processes of mutual development of school and work practices take place" (Akkerman & Bakker 2011, 170). Acknowledging the above, this paper will employ Akkerman and Bakker's (2011) four boundary crossing mechanisms as a lens to understand what is occurring in the MBA ISPs in the Gateway to Industry Schools Program in Queensland, Australia (see Figure 1).

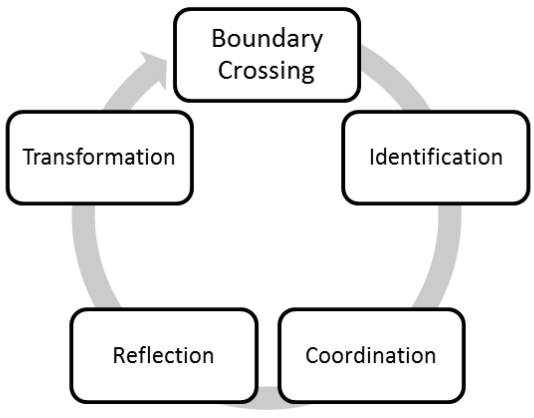

Figure 1: Boundary crossing mechanisms that facilitate knowledge sharing in ISPs.

We now discuss how Akkerman and Bakker's proposed mechanisms may be conceptualised for the MBA ISP.

2.1 Identification of partner contribution

In ISPs, identification is a process of delineating the organisational and human resource differences between two partners. Basic questions are asked of partners, such as who are you, what do you do, and what are you willing to bring to the partnership? The factors for each partner to consider in this process are: (a) demand - verifying and understanding the demand for the ISP and it's real source (industry, school or government); (b) compatibility - potential for cultural compatibility of partners; (c) resources - potential resources including direct funding and in-kind support; (d) roles - clarification of the roles and responsibilities of each partner; (e) skills - the skill-sets and training systems necessary for teachers and students to cross boundaries; (f) models - models of operation; (g) risks - any potential risks that threaten the sustainability of the ISP.

2.2 Coordination among partners

Coordination involving a schedule of repeated interactions facilitates the permeation of boundaries between partners. Coordination between schools and industry is critical to effectively operationalising ISPs. The importance of coordination is supported by the work of Cash et al. (2006) who identified common characteristics associated with an organisation's boundary crossing processes including those objects that are co-produced through coordination. The term boundary objects refers to those phenomena, abstract or concrete that facilitate the crossing of boundaries between multiple social worlds (Star & Griesemer, 1989). The factors for each partner to consider in this process are: (a) agreements - formal and informal; (b) linkages - direct and indirect linkages between partners; (c) curriculum - processes for co-producing; (d) coordination model - individual versus team to coordinate ISP; (e) leadership - additional to coordinator role such as school principal; and (f) geography - close proximity between partners. Clearly and transparently articulating the activities and constraints of partners advance the effective coordination of ISPs.

2.3 Reflection on partnership

This mechanism involves reflection as a means to facilitate partners' "coming to realise and explicate differences between practices and thus to learn something new about their own and other's practises" (Akkerman & Bakker 2011, 145). Reflection may be initiated by either partner and provide opportunities for negotiation for new actions, strengthening of existing arrangements and changing/eliminating existing arrangements. All of these are intended to facilitate border crossing as an on going process rather than fixed one off events. For instance, industry may reflect about what curriculum content best equips students for apprenticeship and work and encourage teachers to consider new curriculum content. While school teachers may have a pedagogical perspective on how the curriculum is taught. Such joint reflective activity can help partners create innovative curricula and cross the traditional fragmented and

often bureaucratic curriculum development process. Reflection is also inclusive of workplace cultural perspectives such as behavioural standards; industry codes of conduct and school behavioural policies.

2.4 Transformation among partners

Finally, transformation occurs progressively as an outcome of the forgoing three boundary crossing mechanisms (see Figure 1). That is, as partners identify the offerings and activities of each other, establish embedded systems to coordinate activities, reflect on the perspectives of each partner, there will likely be genuine transformation or some change in current ISP practices leading to effectiveness within the overall system (Akkerman & Bakker 2011). This definition of transformation is similar to Engeström and Annalisa (2010) who emphasise the importance of qualitative transformation within an overall activity system. Furthermore, in Caldwell's (2004, 96) paper on the strategic transformation of schools he argues that schools should "reflect the uniqueness of the community in which schooling occurs and the forces of the wider environment that shape the knowledge economy".

3 Qualitative case study

A qualitative case study methodology was adopted and positioned against a priori theoretical concepts, a deductive approach using four boundary crossing mechanisms (Akkerman and Bakker 2011; Layder 1998) noted in Figure 1. Despite this prior framework the researchers remained continuously responsive to data that were not absolutely locking into the framework so as not to miss emerging themes. Thematic analysis of the data collected included exploration and coding (see Yin 2009). Explanations and themes were built progressively by aligning a priori codes to the boundary crossing theoretical framework and by making meaningful journalistic notes. Key themes were identified as they related to a patterned response or meaning within the data set. Some themes were based on prevalence within the data, while others were interpreted from the underlying ideas and perspectives of participants.

Interviews and documents were used as data sources. In total, 50 interviews were undertaken in two phases and subsequently transcribed. School and industry interviews were conducted in a semi structured conversational style exploring participants' perspectives on the workings of the MBA ISP. Interview participants included: school principals, deputy principals; subject heads of departments; school teachers; career officers; workplace coordinators; school VET trainers and coordinators; industry project officers, industry community liaison officers; industry apprentice managers and chief executive officers. A broad range of documents were thematically analysed to corroborate the interview data. Some documents were provided by participants at the researcher's request and others were identified by the research team from government websites. Documents were divided into five areas including: industry reports (18); curriculum documents (10); government policy documents (14); government reports (13) and; Gateway school reports (5).

4 Boundary crossing findings and discussion

To keep this paper within scope the key findings of the MBA ISP were collapsed into four tables. These tables align with Akkerman and Bakker's (2011) four boundary crossing mechanisms: identification; coordination; reflection; and transformation. Additional pertinent discussion and quotations from transcribed interviews are also presented to help strengthen and clarify this section of the paper.

4.1 Identification

Table 1 presents findings on the first boundary crossing mechanism, identification, and boundary crossing objects in section 2.1. As noted in Table 1 there were no clear findings under the boundary crossing object *Roles* in any of the ISPs, and none for *Compatibility* and *Risks* in the aerospace and building and construction ISPs. The interesting finding is that each industry leveraged different set of resources and skills development opportunity and developed different models to operate their respective ISP. Given the nature of the diferent models they have implication for teachers' capacity to support the models.

For instance, the aerospace industry together with companies (Boeing, QANTAS, Virgin) persuaded the government of the day to establish a training facility and to take significant action to address skill shortages in aviation. Initially, the government identified schools in close proximity to two major airports to form a cluster arrangement. In contrast, the building and construction ISP model was initiated by the State government which contracted Hutchinson Builders, one of the largest Queensland contruction companies to develop and deliver building and contruction training. Hutchinson Builders worked with Construction Skills Queensland (industry skills body) and schools to provide industry training to students on various large infrastructure projects throughout Queensland. The minerals and energy ISP began with the State government approaching the Queensland Resources Council (industry peak body) with the aim of replicating the aerospace arrangement.

Table 1: **Boundary crossing identification findings.**

Aerospace	**Building and Construction**	**Minerals and Energy**
Demand: strong demand identified by Boeing, Qantas and Virgin	Demand: State government identified need and contracted Hutchinsion Builders (company) to develop and deliver training	Demand: State government, identified need and approached Queensland Resources Council
Resources: minimal State government funding	Resources: some schools identified opportunities to link to Federal funding through Trade Training Centres and Registered Training Organisations.	Resources: minimal State government funding
Skills: Established a training institute through Aviation Australia	Skills: identified pathways for 200 apprentices from schools involved	Skills: Registered Training Organisation involvement
Model: partnership between 24 schools (with orientation toward aerospace industry) and industry	Model: Hutchinson Builders identified partner schools (73 schools and formed 6 school clusters	Model: partnership between 34 schools and 17 multinational minerals and energy sponsor companies, established Queensland Minerals and Energy Academy (QMEA)
		Risks - fluctuating industry funding
		Compatibility – strong community links and kinship ties to industry

The application of the aerospace model proved unsuitable due to statewide needs. Therefore a brokerage model was established where an academy (Queensland Minerals and Energy Academy QMEA, see http://www.qmea.org.au/) was formed to lead and facilitate partnering between industry and schools. Through pre exisiting networks the QMEA engaged companies (such as Billiton Mitsibishi Alliance, Rio Tinto and Anglo America) to sponsor their program and to work directly with schools. As an example of how the aerospace ISP emerged an excerpt from an interview is provided below:

"So Boeing had some local issues themselves, they were being approached by numerous high schools for support, for work experience, for sponsorship and they said they just weren't able to manage it well, because the demand was just too great at all different levels within their system. So they asked the Department (State government) could they come up with some manageable process whereby they could have some quality, targeted relationships with a small number of schools so that they weren't spreading their resources too thin and that there could be some real outcomes." (Principal Eagle High, 2011)

4.2 Coordination

Findings on how each ISP project was coordinated are detailed in Table 2. There were no findings for the boundary crossing object *Leadership* for the building and construction ISP. The aerospace and building and construction ISPs were similar in that they both were coordinated by sole project coordinators or managers. A weakness of this approach is that the focus of the ISP is overly susceptible to the perspective of one individual. On the other hand, the minerals and energy ISP was coordinated via a more typical organisational structure. The QMEA in partnership with the State government and the minerals and energy peak body (Queensland Resources Council) established a team consisting of a chief executive officer, business manager and project officers. This brokerage type model was found to be a strategic catalyst for action throughout the ISP. However, this approach also has its challenges in that it is costly and challenging to execute efficiently across a geographically dispersed State such as Queensland.

Critical to the coordination of each ISP was the close proximity of schools to industry projects. However, the building and construction ISP partnership with schools was constrained when it came to coordinating workplacements as they were relying on large government led infrastructure projects. Assigning students to new project sites away from their schools was a challenge, and although economically viable, this model left the previously engaged schools without a sustainable project. Furthermore, although coordination of the building and construction ISP was initated by the State government, it was in reality based on relationships between individuals rather than institutional arrangements. This is perhaps the reverse of what occured with the QMEA model where it was initially coordinated by an individual but as the demand grew the QMEA was formed to help manage the ISP.

Also critical to the effective coordination of each ISP were pre exisiting and indirect links between industry and school and various community members and organisations. In mosts cases there were teachers and principals who had pre-existing links with community members who were able to support schools to achieve objectives with companies. For instance, one school principal in the minerals and energy ISP was able to negotiate directly with mining mangers at the local football club (see Table 2) where the principal was a coach. The coordination of ISPs is also enacted through agreements or memorandums of understanding (MOU) or contracts that state mutually beneficial objectives. While MOUs may also contain, clearly documented roles and responsibilities, and activities and timeframes for each partner serving as a foundation for effectively coordinating and operationalising an ISP, only the minerals and energy sector adopted a formal MOU.

Table 2: **Boundary crossing coordination findings.**

Aerospace	**Building and Construction**	**Minerals and Energy**
Agreement: MOU is a future goal.	Agreement - no formal MOU in place despite this being a require-ment of Gateway membership	Agreements - multiple formal MOUs and informal arrangements
Linkages: individual schools establish direct networks with industry	Linkages - pre-existing personal links between project manager and industry contacts and some teachers, indirect links between schools and community organisations	Linkages – QMEA project officers with pre-existing industry contacts, project officers are primary link between schools and industry, indirect links between schools and community organisations (sporting clubs)
Curriculum: co production process	Curriculum: co production process	Curriculum: co production process
Coordination model: sole project coordinator liaison between schools and industry	Coordination model: dedicated school coordinator between school and industry	Coordination model: QMEA includes basic organisational structure, dedicated school coordinators between school and industry
Leadership: school principal leadership		Leadership: school principal leadership
Geography: close school geographic proximity to industry (Brisbane airport and surrounding schools)	Geography: school clusters within geographic proximity to work placement sites	Geography: close school geographic proximity to industry (Mining communities)

The aerospace and building and construction ISPs had not formalised arrangements, although aerospace identified an MOU as a future goal. The minerals and energy ISP had executued numerous MOUs over time between schools and companies. Although, MOUs were not seen as critical by some industry partners, school partners (principals and teachers) viewed and valued MOUs as means to ensure commitment and sustainability of ISP programs. This was found to be particularly important for the effective coordination and assignment of human and financial resources to various ISP initiatives. An industry apprentice manger expressed his view on MOUs with the following statement:

"A few years ago we looked at an MOU, and I know (another school) did an MOU with the school. Look, I'm not a formal person. If Susan rings up and says hey, can you come and talk to the kids next Wednesday, we'll be there, and if I fall over and break a leg, someone will be there. I just think we need to support the schools as much as we physically can and whatever support that we can give, we'll be there. Whether that's formalised or not, I don't care, the outcome's not really ever going to change. I just think that we need to be a strong partnership with the school, which we are, and I don't know if it would even change if we did a formalised partnership." (Industry apprentice manager 2013)

4.3 Reflection

Across the research dataset there was considerable evidence of Akkerman and Bakker's (2011) third mechanism, reflection. Participants expressed perspectives on a broad range of challenges encountered by their respective ISPs. Most reflections were openly communicated among partners which enabled challenges to be shared, better understood and in some cases solved. The findings for this mechanism are presented in Table 3. Coming through strongly in the data was the interdependent nature of ISPs. For instance, the focus of the aerospace ISP changed as the industry priorities changed. Initially the focus was on pilot and cabin staff training and maintenance engineers particularly related to Boeing contracts in servicing F111 military aircraft. However, as F111 were phased out of service, and the global financial crisis impacted the aviation industry partnerships changed. New industries such as aviation security, and airport metropolises filled the gap. This was further driven by the minerals and energy sector where there was a steep increase in the need for a fly in fly-out mining workforce. In the minerals and energy ISP there was a similar picture emerging where the objectives of the ISP was impacted by the economic fluctuations in the mining sector. In some instances this resulted in the withdrawal of direct funding from sponsor companies to the provisioning of more in kind support. As noted in Table 3, reflection occured at every level of the ISP including by teachers (have to reskill themselves) and students (over-qualified or wrong skills sets).

An interesting reflection expressed by the building and construction ISP was the over qualifying of school leavers. This view was also a factor in the minerals and energy ISP where school leavers held equivalent or higher qualifications than existing industry employees. To further complicate the issue employee pay scales are sometimes aligned to qualifications. Another consistent finding across ISPs was the negative impact on school timetables and non industry subjects when students were released to industry for work activities. Additionally, there were challenges associated with the lack of industry based knowledge held by teachers. This posed as a problem when teachers were expected to contextualise the curriculum with industry examples. The issue was addressed in part by industry provisioning professional development and various resources for teachers.

Table 3: **Boundary crossing reflection findings.**

Aerospace	**Building and Construction**	**Minerals and Energy**
Address skill shortages and develop partnerships	School leavers over qualified for apprenticeship	Over qualified school leavers for apprenticeship
Program focus dependent on project coordinator experience e.g. industry vs. school	Industry will not pay higher rate for qualified school levers	Industry will not pay higher rate for qualified school levers
As industry priorities change the nature of the partnership changes (e.g. curriculum content changes)	School release for industry-based subjects impacts on school timetable and non-industry subjects	School release for industry based subjects impacts on school timetable and non industry subjects
Level of regulation in airports restricts student site visits	Training programs need to be mobile to enable delivery where infrastructure projects are located	Purpose: address skill shortages and develop partnerships
Industry lack understanding of what schools do		Economic fluctuation impacts on school industry partnership sustainability
		High teacher turnover rate Shortage of teachers with industry based knowledge

4.4 Transformation

The Gateway to Industry Schools program in Queensland aspired to transform the TVET sector in a way that schools and industry collaborate to produce human capital necessary to meet the economic demands of the State. Immediate outcomes included the capacity of teachers and educational managers to be sensitive to these needs and to have access to the resources to achieve these goals. Findings in the MBA ISP are evidence of the reality and challenges of such transformation. Although each ISP had taken a somewhat different approach, they had successfully adapted and embedded industry based learning opportunities into their curricula. This process involved filtering the industry based curriculum through: (a) school approval processes; (b) VET standards and audit requirements; and (c) industry body approvals. There were specific examples of State approved school subjects (such as aerospace and other STEM subjects) as well as examples of contextualising existing subjects (earth science with mining geology knowledge). Moreover, the curriculum content was often co-taught by industry trainers and school teachers under the auspice of registered training organisations who could issue qualifications.

Table 4: **Boundary crossing transformation findings.**

Aerospace	**Building and Construction**	**Minerals and Energy**
Institutionalised ISP curriculum: accredited by State government school education authority	Institutionalised ISP curriculum: accredited by State government school education authority	Institutionalised ISP curriculum: accredited by State government school education authority
VET approved	VET approved	VET approved
European Aviation Safety Agency (EASA) approval as training organisation	Standard industry-based safety training	Standard industry based safety training
Negotiatiated contextualised aviation related qualifications from aircraft maintenance engineering to cabin crew training.	Negotiated contextualised Maths, English and Science Certificate I (year 10) Certificate II (year 11-12)	Negotiated contextualised Science, Maths subject (called QSMART)
Eagle State High School trans-itioned from a general high school to an aviation focussed school		Resources Industry Orientation Certificate I and II
		Engineering camps for professional pathway

5 A useful lens to understand industry-school partnerships

Boundary crossing theory has provided a revealing framework from which to explore ISPs. Our purpose was to explore how partnerships were developed between three major industry sectors and schooling at a systemic level and implications it may have for human resource to support the same. Drawing on boundary crossing theory leads us to suggest four necessary propositions for ISPs to advance their objectives and overcome boundaries between partners.

- ISP partners need to identify and understand the types of boundaries and human capacities supporting common interfaces that exist between schools and specific industries.

This includes identifying the obvious generic differences and those that are peculiar to an industry or individual company. Such knowledge helps to clarify and manage expectations and to identify areas of genuine common interface where partnerships can develop. Most critical is the identification of the specific motivation for each partner's involvement as well as the factors that could dramatically change or end the partnership. For instance, variables that may be external to the ISP such as economic fluctuation or a policy change.

- Effective ISP coordination models across partner boundaries is dependent on the geographical scope of activity and availability of a competent human resource.

For ISPs that operate in geographically dispersed locations, ISPs may be best served by a small broker type organisation that can act as a structural catalyst across jurisdictional boundaries. This model is able to converge the perspectives of partners and draw upon school and industry linkages throughout the ISP system. The staffing and travel costs of this model may prove prohibitive for ISPs with limited budgets. ISPs that operate in more localised settings will benefit from a sole coordinator or project manager that can work directly and efficiently with stakeholders. It should be noted that this model is susceptible to the personal bias of the sole coordinator. To ensure sustainability of ISPs, ongoing consideration needs to be given to both models in the area of succession planning.

- ISPs who practice reflection and address challenges transparently can expect to develop innovative and sustainable programs.

Our research found that there are many challenges that potentially impact on an ISP realising it's objectives. However, when problems are communicated openly among partners there is typically a willingness from all partners to arrive at innovative solutions that are acceptable to all. Equally, where partners do not practice reflection and become self-serving in their endeavours the ISP will reach a threshold that may be unsustainable.

- ISPs who seek to integrate programs into existing external systems will transform and realise school to work transitions that meet the needs of all partners and ultimately the end beneficiary, the school student.

In this study each ISP employed different models of operation, however there were some key common elements. This led to the mapping of the following five step transformation process.

1. ISPs transformed practices through the application of boundary crossing mechanisms.
2. ISP transformed practices through the co production of knowledge, which in this case was science and maths curriculum.
3. ISPs transformed by embedding co produced curriculum in external pre-existing systems.
4. The approved curriculums were co-taught/trained by school teachers and industry trainers and mentors. This occurred on school and industry premises employing innovative knowledge and technology not available in standard school programs.
5. Though arduous, this process ensures that school students are better prepared for the world of work because the gaps in standard school curriculums have been adequately addressed by co produced industry based curriculums. Students who participate in these programs are making school to work transitions or in some cases further education or training.

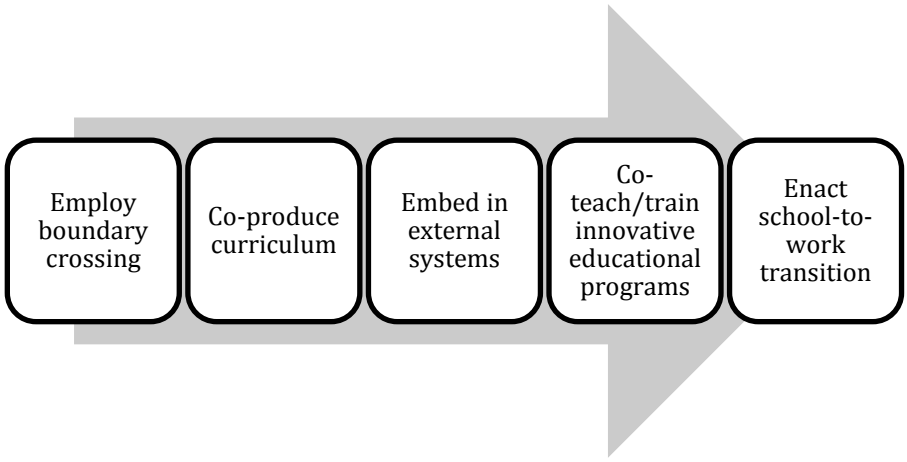

Figure 2: Five-step industry-based curriculum transformation process

Boundary crossing requires disparate organisations to identify, coordinate and activate common spaces. These don't happen spontaneously but require clear guiding principles, as noted in the theoretical framework and our previous paper (Flynn, Pillay & Watters 2014). We have also acknowledged the work of previous researchers who contributed to theory on boundary crossing and conclude that we found it a particularly useful lens for better understanding the dynamics of ISPs. A more detailed understanding of the specific boundaries of schools could be explored in future research together with practical strategies to connect schools and industry.

Acknowledgements

This research was supported under Australian Research Council's *Linkage Projects* funding scheme (project number LP100200052: Industry school partnerships project: A strategy to enhance education and training opportunities). Support was also provided by the Queensland Department of Education and Training, and Independent Schools Queensland.

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TVET@sia The Online Journal for Technical and Vocational Education and Training in Asia

CITATION:

Flynn, M., Pillay, H., & Watters, J. (2015). Boundary crossing – A theoretical framework to understand the operational dynamics of industry-school partnerships. In: TVET@Asia, issue 5, 1-17. Online: http://www.tvet-online.asia/issue5/flynn_etal_tvet5.pdf (retrieved 23.07.2015).

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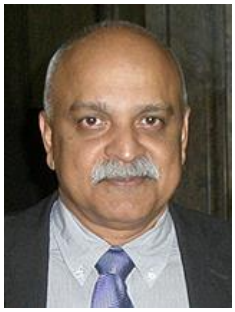

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